Traffic Decision Support: Aspirations and Practical Challenges

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My Background

- Former Director, Advanced Transportation Technologies, U.S. DOT Volpe National Transportation Systems Center
  - ITS Strategic Research Plans 1992-2014
  - Safe and Efficient Travel through Innovation and Partnerships in the 21st Century (SafeTrip-21) 2008-2010
  - Safety Pilot Connected Vehicle Model Deployment, Independent Evaluation 2012-2014
- U.S. DOT ITS Senior Policy Task Force
- Charter member, Intelligent Transportation Society of America
- Advanced Technology Committee, American Society of Civil Engineers, Transportation & Development Institute

Traffic Decision Support

Safe and efficient trip decision-making needs timely information on alternatives, current (and to the extent possible anticipated) hazards and/or disruptions – regardless of the cause – as well as personal and societal costs for suitable options for a given travel purpose.

For most personal travel, trip time and cost decisions consider:

- Prevailing and anticipated road, traffic, and weather conditions
- Network alternatives (including access to preferential services or express traffic facilities)
- Intermodal connections
- Fuel price, tolls, and fees
- Parking availability / cost
- Environmental restrictions
- ~~Traffic network productivity~~

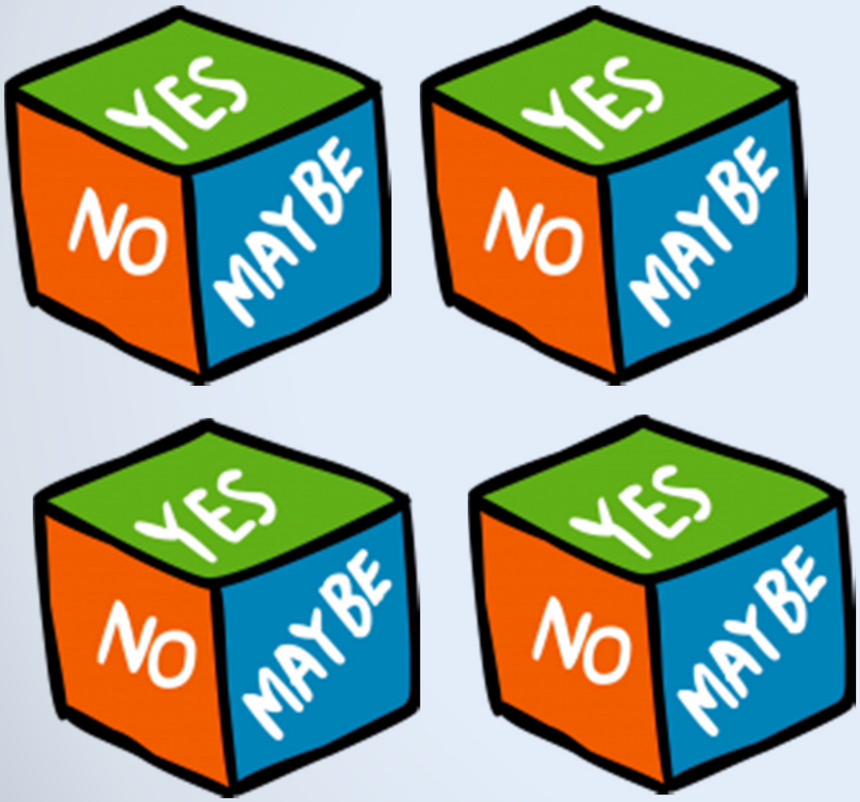
Traffic Decision Puzzle Pieces

- Known knowns
  - Trip distance over network segments, including multi-modal linkages
  - Prevailing traffic, weather and road conditions (increasingly and more widely so)
  - Mean trip travel time / time of arrival, and associated variance
  - Scheduled events
  - Out-of-pocket costs

- Known unknowns:
  - Actual travel time
  - Unscheduled events
  - Impending incidents and disruptive impacts
  - Evolving impacts from decisions by others
  - Impact extent and duration until ‘normalcy’ is restored

Traffic Decision Support

Decision motives



Decision makers

Public Sector Aspirations

❑ Traffic Safety

- Weather and Road Conditions
- Curve / speed zone warning
- Traffic congestion ahead alert
- Intersection movement assist
- Pedestrian / bicycle alerts
- Blind spot / overtaking assist

~34,000 fatalities annually

~$100B economic burden

~2B gallons wasted fuel

~2B metric tons GHG

❑ Efficient Mobility

- Optimal transportation network performance / productivity
- Transit / ride sharing utilization
- Avoid congestion and delay
- Provide travel time reliability

❑ Eco-Transportation

- Avoid wasteful fuel consumption
- Foster low emission alternatives and informed travel decisions
- Maximize persons and/or cargo moved per ton of GHG emission

Transit / Freight Aspirations

❑ Operational Safety

- Weather / wind information
- Road condition information
- Traffic alerts / warning:
  - ✓ Blind spot
  - ✓ Lane departure
  - ✓ Forward collision
  - ✓ Curve speed / rollover
  - ✓ Drowsy / distracted driver
  - ✓ Bike / Ped conflicts

Metro Transit, MSP

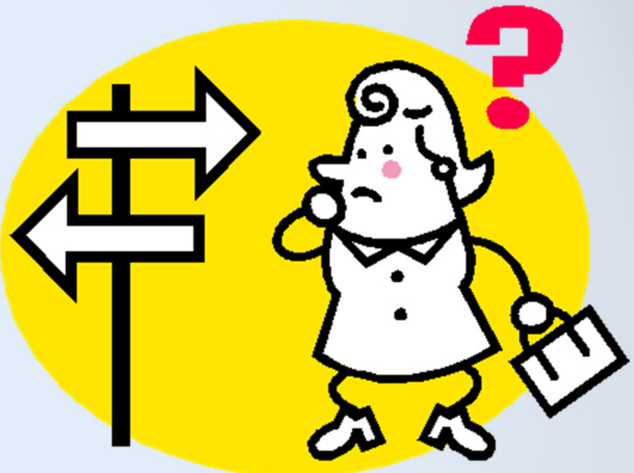
Port of Los Angeles

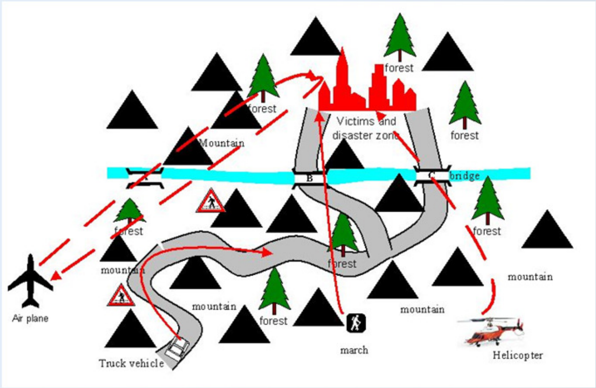
❑ Operational Productivity

- Expeditious trips; efficient driver utilization
- Fuel efficient, traffic-aware routing
- Predictable travel and transit times
- Efficient intermodal transfer operations
- Parking availability when and where needed

Traffic Related Decisions

- **Personal Travelers** – trip frequency, where, when, route and mode choice, trip-chaining behavior
- **Traffic Managers / Engineers** – traffic signals, route designation, incident management, traffic reports
- **Fleet Dispatchers** – demand analysis, service planning, scheduling, routing, operating constraints, disruptions
- **Logisticians** – delivery planning, JIT scheduling, dynamic routing, optimization, distribution alternatives
- **Public Safety** – traffic law enforcement, emergency response, closures, detours, evacuation operations
- **Transportation Planners** –travel demand, traffic forecasts, congestion, modal split, safety and efficiency

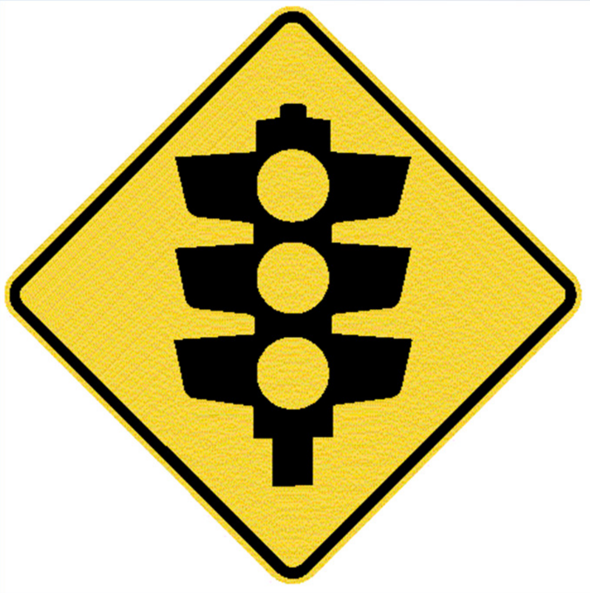




Personal Decision Attributes

- Historically, limited reliance on traffic information for most trips; greater interest by younger generations
- Interest in traffic / travel information spikes when stuck in traffic or in unfamiliar / dynamic situations
- Willingness to participate in crowd sourced traffic monitoring – subject to privacy considerations
- Response to information correlates to perceived accuracy
- Expectation that traffic information be offered as a bundled service without a separate charge

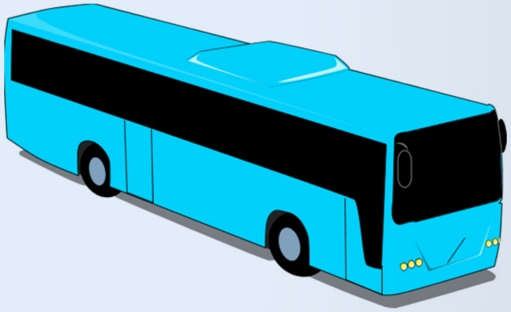
Traffic Manager / Engineer



- Interest rooted traffic operations and control devices (signals, message signs, traveler information systems) and/or incident response
  - Interest in relatively fine-grain traffic data (i.e., intersection movements and throughput)
  - Interest in traffic safety, flow, travel time / delay, and congestion metrics
- Desire for video imagery or human observation to confirm and assess situations
- Limited willingness / ability to pay for routine traffic data; also limited expertise / time to make use of information
- Numerous, independent traffic jurisdictions; often face conflicting perspectives on addressing traffic problems

Fleet Dispatcher Attributes

- Situational awareness desire relative to sustaining on-time operations and labor rule compliance
- Rerouting typically limited by commercial vehicle and bus traffic restrictions



- Taxi / limo operators subject to traveler suspicion of indirect routings
- Recovery of traffic information cost varies – whether as a pass-through charges or through operating efficiency gains

- Communication links with vehicles afford possibilities in traffic probe data collection and exchange

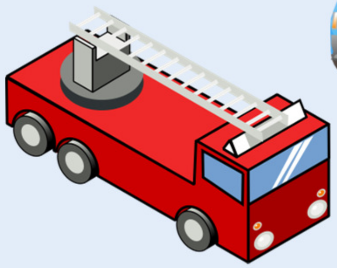
Logistician Attributes

- Similar to fleet managers but operating at a larger scope and scale, with intermodal options
- Strategies to pre-position resources to minimize traffic related disruptions
- Keenly aware of costs and bottom line implications – United Parcel Service for instance:
  - 17 million parcels daily, throughout 200 nations, via air, rail, marine, trucks, and bikes
  - 5 minutes of traffic delay across U.S. operations costs $105 million annually
  - Traffic decision support covering 20% of fleet is saving 1.5 million gallons of fuel and eliminating 14 tons CO_2 annually

Public Safety Attributes

- Interest in traffic situational awareness and reporting during incident response and management

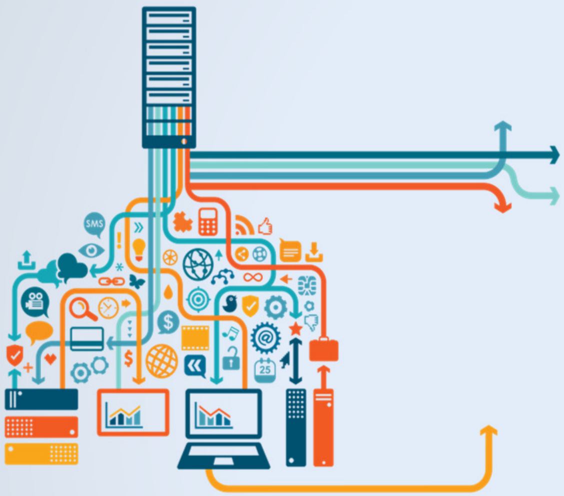
- Traffic information is vital to incident response yet incidental to public safety management overall



  - Interest in dynamic traffic routing for rail grade crossings and drawbridges

- Historical information can be rendered irrelevant as a result of catastrophes
- Degraded or destroyed infrastructure (and staffing) often impairs data access and distribution
- Situations can change rapidly, requiring dynamic planning and response capabilities

Transportation Planners

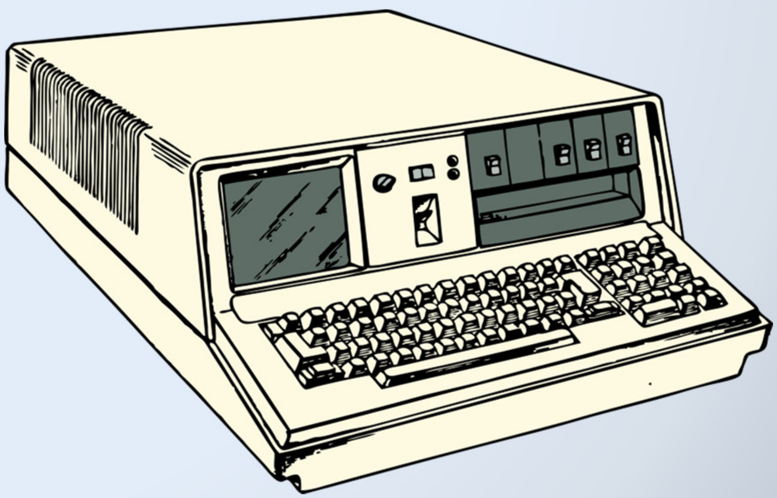


- ❑ Focus on archival and trend data more so real-time traffic information
- ❑ Interest in traffic meta data and data suitability / compatibility
- ❑ Focus on travel corridor and/or regional scale, with emphasis on overall capacity and efficiency
- ❑ Typically lack organizational responsibility and/or field capability for systemic traffic data collection
- ❑ Shared interest in traffic volume counts, vehicle weight / classification, and traffic speeds with transportation managers / engineers.

Traffic Decision Support Milestones Over the Years

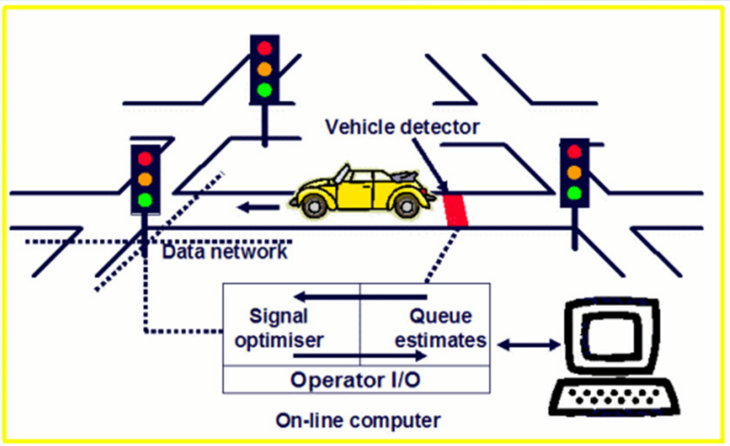
A long and winding road influenced by technology innovation:

- 1970-1980's – Electronic Route Guidance
- 1990's – TravTek (Travel Technology)
- 2008-2010 – SafeTrip-21
- 2015 Connected Vehicle Pilots



Electronic Route Guidance

- During 1960 – 1980, traffic-aware route guidance heralded as the most important urban traffic advancement in since freeways
- If space age electronics could be used to transport a few men 200,000+ miles to the moon, why not use it to move hundreds of thousand people in cities



Siemens Traffic Controls

- Urban Traffic Control Systems (UTCS) viewed as an enabler for computerized traffic signal control and centralized electronic traffic management.
- Dynamic traffic information a distinguishing ERG feature, with centralized computer processing.

ERGS

Electronic Route Guidance System (ERGS 1968-1970)

- ‘V2I’ concept developed by FHWA in cooperation with General Motors – derivative of GM Driver Aid Information and Routing (DAIR) system circa 1966
  - Vehicle destination code provided to traffic signal communications unit

Image: FHWA

- For a small network, daily cost benefits from delay reduction were estimated at $3,270 (~$19,200 in current dollars)
- Benefit advantage over static guidance offset when vehicle unit costs are greater than $135 (~$795 in current dollars)

ERGS Contemporaries

- Comprehensive Automobile Traffic Control System (Japan 1973-1979)
  - ¥ 7.3 billion (~$ 30 million; ~$120-150 million in current dollars)
  - Inductive loop data communication
  - 11% estimated travel time savings

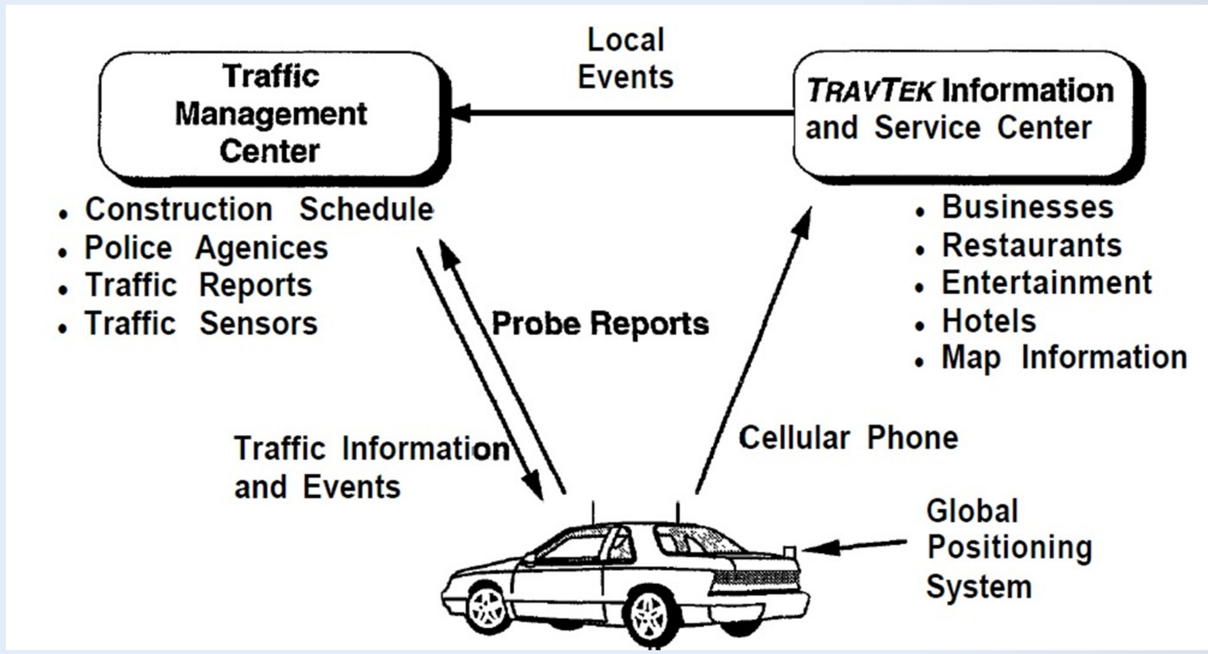
Image: Toyota

- ALI - Autofarer Leitung und Informationsystem (Europe late 1970's)
  - Ali-Scout (combination of ALI and AUTOSCOUT) estimated to reduce travel time by ~5% as part of the mid-1990's FASTRAC project in MI

Image: Toyota

TravTek (1992-1993)

- ~300 drivers
- 1,488 traffic network links
- traffic data via sensors and probes
- 1min traffic updates



Select Findings (real-time traffic used but not evaluated)

- ~80% user favorability; perceived desirability highest for trips in unfamiliar areas
- Travel times reduced by up to 25%; but typical savings were <1.5 min given short trip lengths
- Willingness to pay: 50% take-rate at $1,000 purchase or $34 weekly rental; ~$250 and $6 weekly for traffic information alone

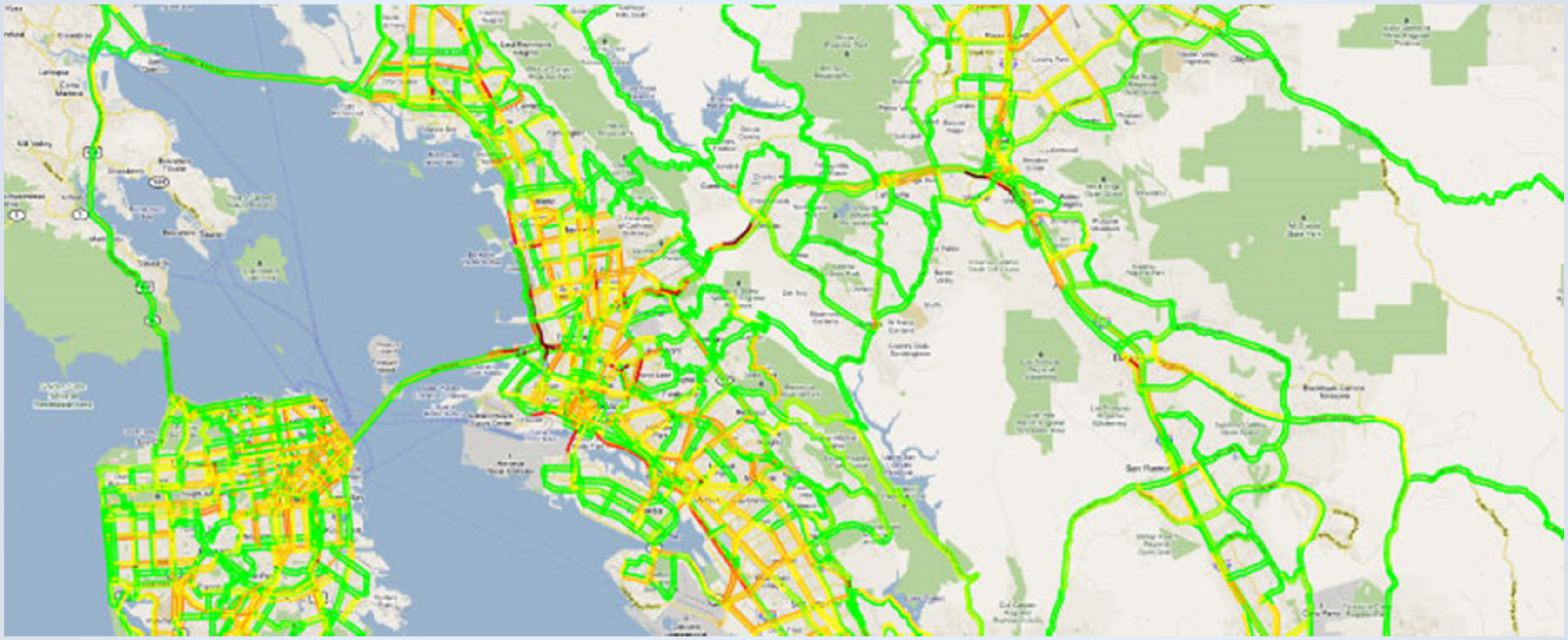
SafeTrip-21 (2008-2010)

- $30+ million public-private field test partnership
  - 20 private organizations
  - 17 state transportation agencies
  - 6 public sector planning and public transportation agencies
  - 2 research universities
  - thousands of travelers

U.C. Berkeley

- Multimodal applications
  - Smart phone road traffic probe monitoring
  - Foresighted 'traffic congestion ahead' driver alerts
  - Long-distance, multi-state corridor traffic-aware travel time 'now-cast'
  - Corridor scale travel planning based on integrated 'real-time' traffic, transit, and parking data – along with cost and environmental factors

SafeTrip-21: Traffic Data

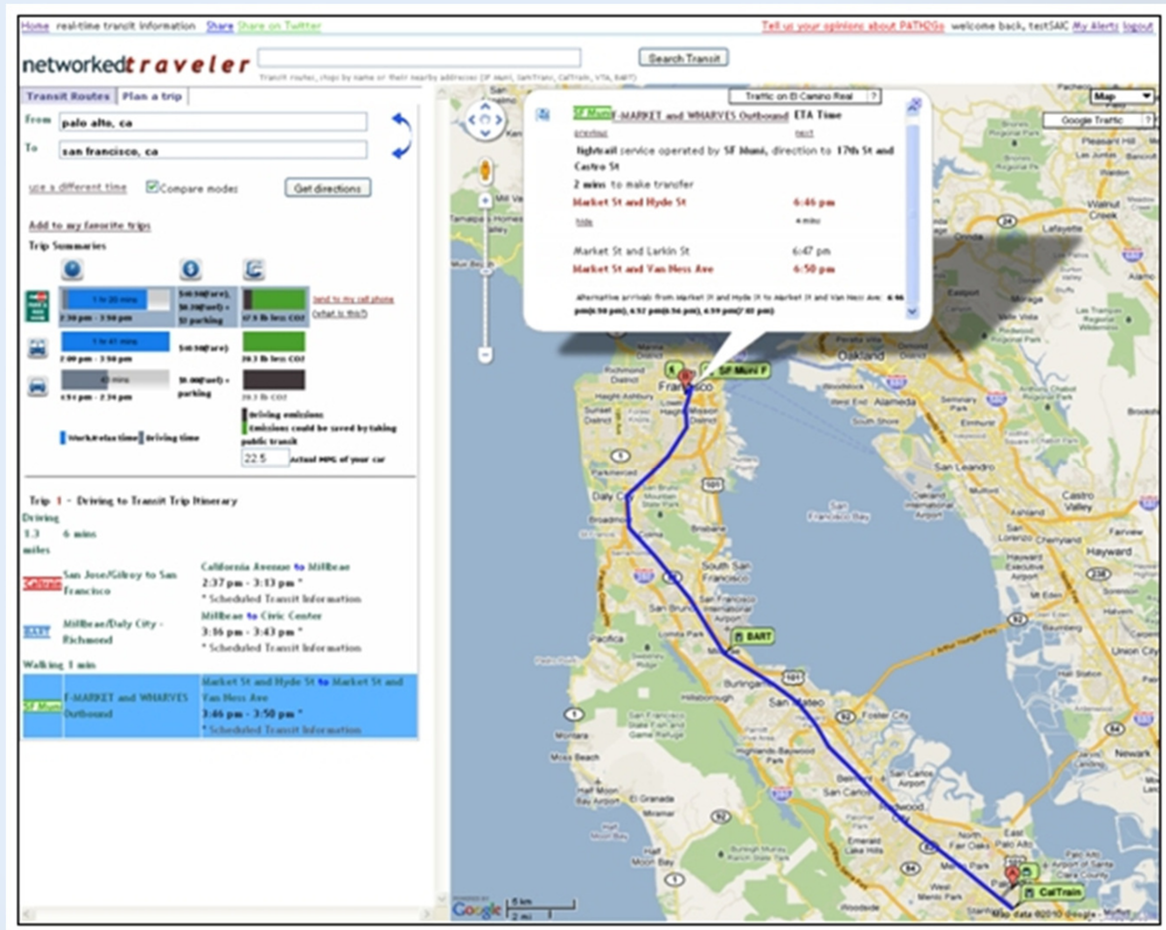


U.C. Berkeley

- 5,000 users in SF Bay Area
- Crowd sourcing feasibility
- Privacy sensitive sampling
- ~5% traffic stream sample
- Up-to-the-minute updates
- Real-time traffic flow map

SafeTrip-21: Trip Planner

- Integrated trip modal choices
  - Commuter Rail
  - BA Rapid Transit
  - Light Rail
  - Bus / BRT
  - Walk / Bike
  - Automobile
- Decision info:
  - Time
  - Cost
  - Carbon Footprint
- 'Real-time'
  - Transfer Guide
  - Parking space
  - Routing update



U.C. Berkeley

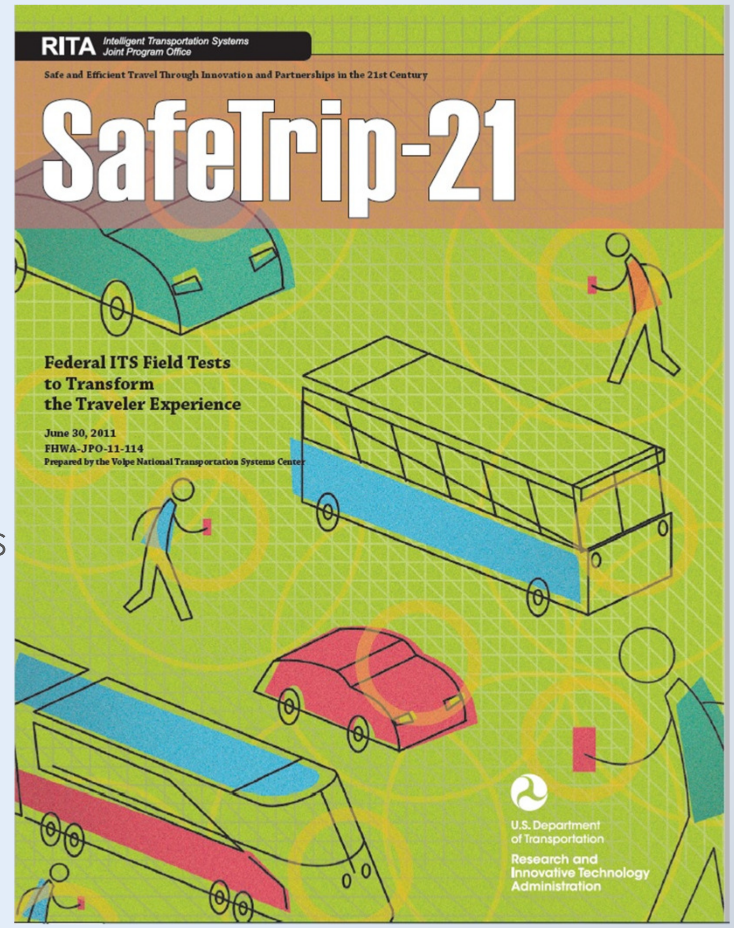
SafeTrip-21: Travel Time

- I-95 Corridor
  - Portland, ME to Orlando, FL
  - INRIX Traffic Data
- Coverage
  - 11,000 road network segments
  - 4,700 freeway miles
  - 900 arterial miles
- Decision info:
  - Travel Times
  - Traffic Status Map
  - Transit options -BWI to/from DC

I-95 Corridor Coalition

SafeTrip-21 Revelations

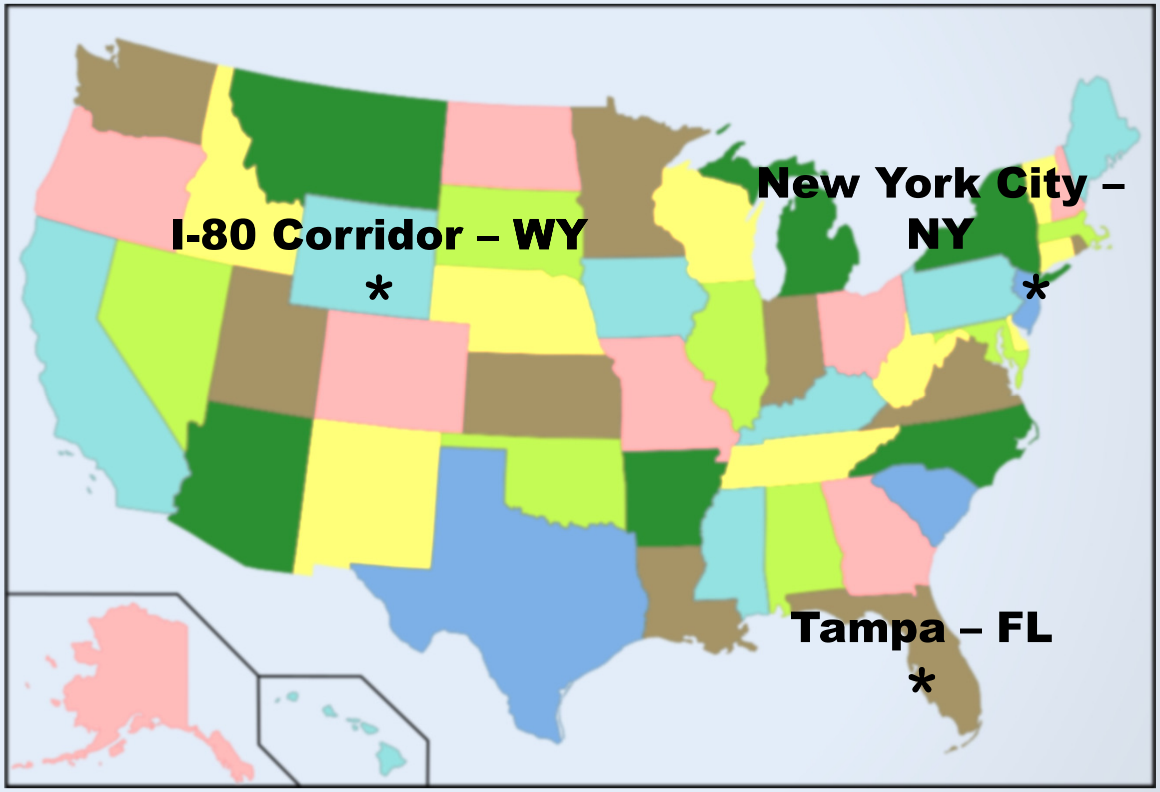
- Smart phones have disruptive potential; and challenged views regarding DSRC-exclusive V2V/V2I future, as well as public and private traffic data roles
- Probe traffic data is ascendant; attractive private sector potential due to scope and scalability attributes
- Crowd sourcing traffic data viable if privacy concerns overcome; ~5% of traffic stream sufficient in peak-period traffic conditions
- ‘Real-time’ multi-modal traffic / trip planning information derived irrespective of jurisdictions
- Marketing / meaningful benefits needed to attract and sustain voluntary data sourcing participants and/or users
- Travel information can prompt expectations – resulting in public agency ‘fear of success’
- Partnership can be mutually advantageous



http://ntl.bts.gov/lib/40000/40300/40353/FHWA-JPO-11-114.pdf

Connected Vehicle Pilots

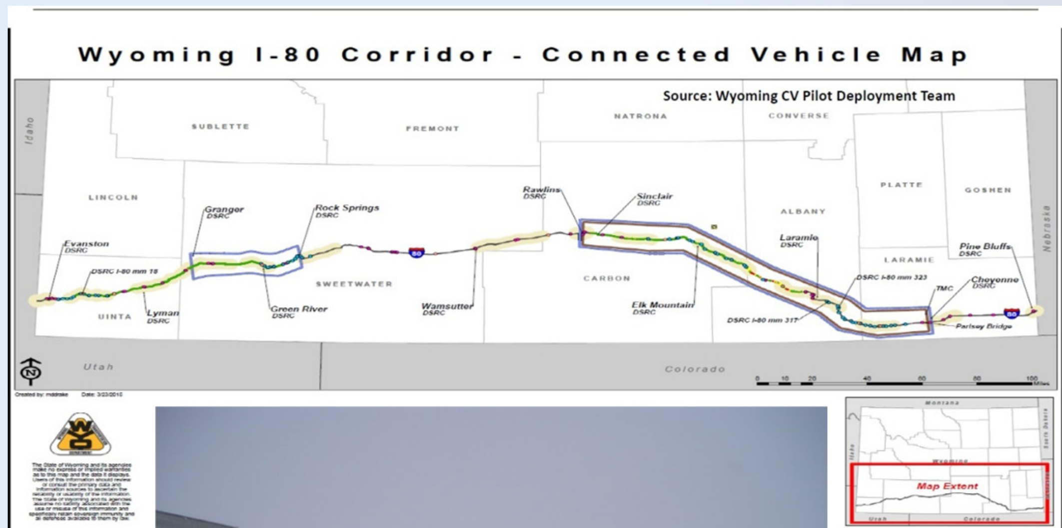
- Large-scale, multi-year, beginning in 2015
- Multi-phase:
  - Concept development
  - Proof of concept
  - Deployment & operations
- 2012-2014 Safety Pilot Counterparts



Connected Vehicle Pilot - WY

- I-80 Corridor
  - 400 mile route; 4,000-6,700 truck AADT
  - ~50 wind-related truck 'blow-overs' annually
  - Severe Wx and lengthy winter road closures
  - Other routes require 2-3 hours more driving

- Applications
  - Road Weather Advisories
  - Spot Weather Travel Impact Warning
  - Weather-Responsive Variable Speed Limit
  - Freight Dynamic Travel Planning



Wyoming DOT

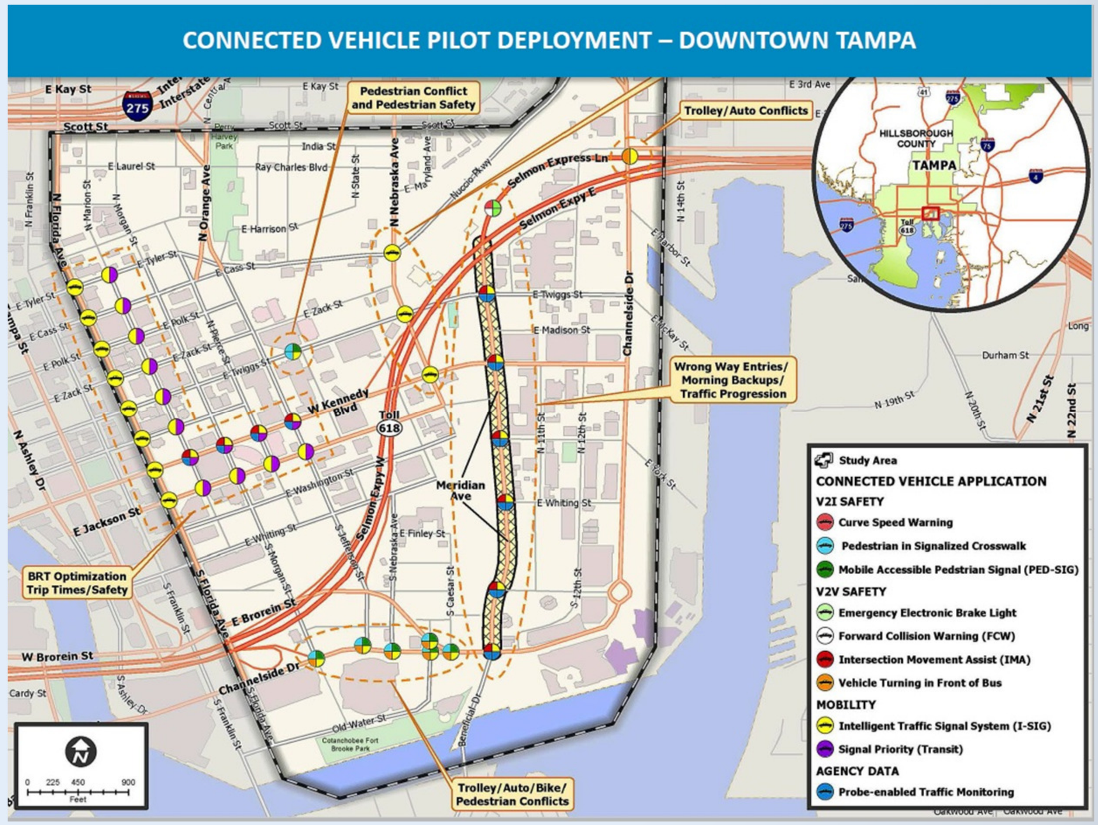
Connected Vehicle Pilot - NY

- New York City
  - ~240 high accident locales
  - 10,000 city / fleet vehicles
  - 12,700 traffic signals w/BSM
  - Traffic simulation model

- Applications
  - Red Light Violation Warning
  - Pedestrian in Crosswalk
  - Vehicle Turning Right in Front
  - Mobile Pedestrian Signal
  - Bike Basic Safety Message
  - Freight Dynamic Travel Demand and Performance

Connected Vehicle Pilot - FL

- Tampa
  - Reversible traffic lanes
  - Bus/Trolley signal delay
  - Rear-end and red- light running crashes
  - Pedestrian/bike road and trolley traffic conflicts



- Applications:
  - Wrong way traffic and curve speed warnings
  - Ped in crosswalk
  - Mobil pedestrian signal
  - Intersection movement assist
  - Intelligent traffic signals
    - ✓ Transit Signal Priority

Automated Traffic

- Conventional driving
  - Compensates for human driver inattention
  - Somewhat confounding for other drivers
- Traffic speed harmonization
  - Potential to improve highway throughput
  - Possible reductions in vehicle emissions with improved fuel economy
- Vehicle platoons
  - +15% truck fuel economy
  - + 200-300% freeway lane throughput; would require corresponding upgrades for freeway exits and downstream arterial streets
  - Cooperative V2V communications needed to stabilize vehicle separation

Freightliner

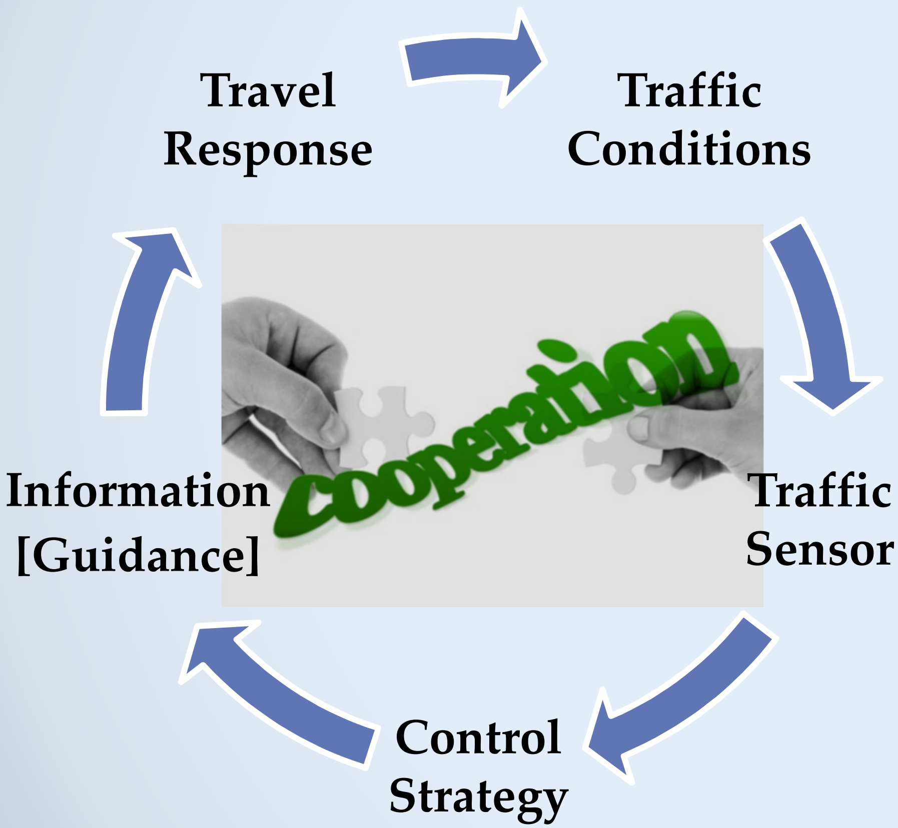
U.C. Berkeley

Practical Challenges

- Traffic decision support financing – in light of benefit and cost mismatches
- Traffic data collection, packaging, and distribution, with targeted valuation and monetization for diverse market segments
- Traffic modeling, simulation, and optimization – with predictive capabilities
- Traffic operations impact and recovery forecasting
- Cybersecurity and Privacy
- Data ownership, rights, and records management
- Information and liability

http://www.quotesforthemind.com/

Opportunities



- ❑ Informed traffic decision making
  - Discrete, individualized traffic control strategies that relieve congestion disproportionally
  - Collaborative traffic decision optimization
  - Anonymous O-D data sharing
- ❑ Faster than real-time traffic decision support
- ❑ Distributed, cooperative shared control
- ❑ Gamification or other behavioral incentives

Questions